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Original Article

Injury surveillance information system: A review of the system requirements

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ABSTRACT

Purpose: An injury surveillance information system (ISIS) collects, analyzes, and distributes data on injuries to promote health care delivery. The present study aimed to review the data elements and functional requirements of this system.

Method: This study was conducted in 2019. Studies related to injury surveillance system were searched from January 2000 to September 2019 via the databases of PubMed, Web of Knowledge, ScienceDirect, and Scopus. Articles related to the epidemiology of injury, population survey, and letters to the editor were excluded, while the review and research articles related to ISISs were included in the study. Initially 324 articles were identified, and finally 22 studies were selected for review. Having reviewed the articles, the data needed were extracted and the results were synthesized narratively.

Results: The results showed that most of the systems reviewed in this study used the minimum data set suggested by the World Health Organization injury surveillance guidelines along with supplementary data. The main functions considered for the system were injury track, data analysis, report, data linkage, electronic monitoring and data dissemination.

Conclusion: ISISs can help to improve healthcare planning and injury prevention. Since different countries have various technical and organizational infrastructures, it is essential to identify system requirements in different settings.

Introduction

Injury is an event resulted from the external causes which may occur intentionally or unintentionally and is a key topic in the social and economic domains.[1] Injury imposes a heavy burden on different communities, especially in low-income and less-developed countries.[1,2] However, in developed countries, adequate investments, public culture promotion, and media advertisement have assisted in overcoming this issue.[2,3] As predicted by the World Health Organization (WHO), injury caused by motor vehicle accident will be the third leading cause of life lost around the world by 2020, and contribute to 16% of the burden of diseases worldwide in 2030.[4]

It is notable that many injuries can be prevented with the aid of effective approaches. For instance, if the injury indices are calculated and reported precisely, it can be used to make the policy and mitigate the burden of injury, as well as optimize the provision of services.[5] To achieve the goal and apply WHO's injury surveillance guidelines, many countries, such as the United States (US), Canada, Australia, and China started to use computers for injury data management.[6–8] In fact, the management of a huge amount of injury data (e.g. who, when, how, why, and where) demonstrates the need for injury surveillance information systems (ISISs).[9] The system facilitates managing injury data for making a better plan in the healthcare sector and directing research endeavors in the field of injury.[1] Moreover, the development of strategies and the implementation of injury prevention protocols in the healthcare system can be simplified by using data and reports derived from this system. These data can help to reduce injury-related morbidity and mortality. And the system can be able to share data integrated with other information systems.[10] Other advantages of ISIS are increasing access to data at the right time, enhancing the quality of care, reducing medical and medication errors, decreasing documentation time, linking different sources of injury data, and providing rich data for research.[5,10]

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The European association for injury prevention and safety promotion noted that the management of injury data is a difficult and challenging process. Regardless of the system design and implementation, it seems that integrating various sources of injury data needs double effort.[11] However, many researchers believe that the benefits of using ISIS are more than its challenges and the system can help to develop preventive programs which eventually decreases injury and violence.[1,10,12]

In order to collect injury related data, different countries have adopted various programs and systems. The joint action on monitoring injuries in Europe, the Canadian hospitals injury reporting and prevention program, the injury data online tool, the injury surveillance system unit in Australia, hospital-based injury surveillance systems, the Shantou-emergency department (ED) injury surveillance project in China, and the national injury surveillance system in South Korea are some of these programs and systems.[13–16] It is noteworthy that despite developments in technology and recommendations on the use of ISIS to prevent injuries and reduce the rate of mortality, the process of developing and using such a system is globally slow especially in developing and underdeveloped countries.[17,18] In other countries, a majority of these systems aim to report the proportion and characteristics of injuries in the at-risk population,[15,16] and there is no global standard for collecting injury data or a unique list of functional requirements for developing this system.[9,19] In fact, as essential data may be lost and misinterpreted in the manual and non-electronic documentation systems and this in turn may lead to leave policymakers facing a shortage of information, the electronic collection and transfer of injury data has been recommended.[20–22] As noted in WHO's injury surveillance guideline, the amount and types of the data collected by an ISIS depend upon the country's health system priorities as well as available resources. Therefore, apart from the minimum data set (MDS) suggested by WHO, extra information can be added based on the specific requirements.[1] Not only data elements can be various in such a system, but also system functions can be defined according to the users' requirements.[9] For example, ISIS should be user-friendly, able to analyze data, and provide an easier communication and connectivity between the data resources.[22] However, few researchers have addressed different types of the data and the functions that can be used in an ISIS. Therefore, this research aimed to review studies in which the data and functions of ISISs have been discussed. This study can help to gain a better understanding of the system and facilitate to design a more complete system in the future.

Methods

It was a review study conducted in 2019. In this research, we focused on the studies in which data elements and functions of ISISs were discussed. To retrieve the articles, extensive literature search was conducted via the databases of Web of Science, ScienceDirect, Scopus, and PubMed from January 2000 to September 2019. The keywords were "information system", "injury", "wound", "trauma", "surveillance", "injury surveillance information system", "injury data network", and "public health surveillance" which were combined by using and/or Boolean operators. The terms were selected based on the MeSH terms and the keywords used in the related articles. A medical librarian was also consulted in developing search strategies. In addition, the reference lists of the relevant articles were investigated to find other studies. In some cases, the authors of the papers were contacted to obtain the full text of the articles. Articles merely related to the epidemiology of injury, population survey, and letters to the editor were excluded, while the review and research articles related to ISISs were included in the study. Finally, citation analysis was conducted to detect any additional relevant records that might be missed in the initial database search.

Initially, 324 articles were identified. After removing duplicates, two researchers screened the retrieved papers to identify the relevant papers by reading the title and abstract. Removing irrelevant papers, full-text articles were examined and some of them were excluded due to poor consistency with the aim of the research. Finally, 22 articles remained for the review study. Having reviewed the articles, the needed data were extracted and the results were synthesized narratively. Fig. 1 illustrates the process of searching articles.

Results

As mentioned previously, 22 articles were selected for further analysis. The distribution of the published papers per country showed that Australia had the largest number of published papers in the field of study ($n = 4$). The highest number of the relevant articles ($n = 3$) was published in 2009, 2011 and 2016. The results of the studies were divided into the ISIS data elements and ISIS functions. A summary of the selected articles is presented in Table 1.

ISIS data elements

The results showed that most articles emphasized on the use of the MDS for injury surveillance. As suggested by WHO, the MDS includes demographic and injury-related variables, such as place of occurrence, activity, injury mechanism, intent and nature of injury.[1] However, apart from the MDS suggested by WHO, many other types of data have been recommended to be used in injury surveillance systems. Some of these data are summarized below.

Core and supplementary data

In some studies, the data elements of ISIS were divided into two categories of core and supplementary data and each category included a mandatory and optional MDS.[1,13,26] The core data consisted of a personal identifier, place of occurrence, activity, nature of injury, injury mechanism, and intent of injury, whereas the optional data set comprised of external causes of injury, injury severity, race/ethnicity, date/time of injury, and disposition.[1] The supplementary data were related to the type of injury. For instance, in a traffic accident, in addition to core data, type of the road and mode of transport can be recorded as the main supplementary data, and data, such as type of the vehicle can be recorded as optional supplementary data.[1,13] In the injury data base (IDB) which was developed by joint action on monitoring injuries in Europe, a full injury surveillance data set (FDS) was defined by collecting and linking the injury data from the EDs of hospitals in European countries. In this data set, 24 data elements were selected as the core IDB/FDS data and included unique national record number, date/time of treatment, follow-up attendance, and the country sharing the data.[11]

In another study conducted by Sklaver et al.[24] on the implementation of ISIS in Columbia, El Salvador and Nicaragua, the MDS was developed by using the international classification of external causes of injury and WHO's guidelines. They concluded that physicians, nurses and hospital managers as well as the education committee and members in charge of injury surveillance need to be educated for accurate documentation. The MDS recommended by Sklaver et al.[24] included mandatory core data, such as intent and mechanism of injury, object/substance producing injury, place of occurrence, activity when injured, alcohol use, psychoactive drug or substance use. The optional core data included type of violence, transport, place, sports, and occupation. In this study, the

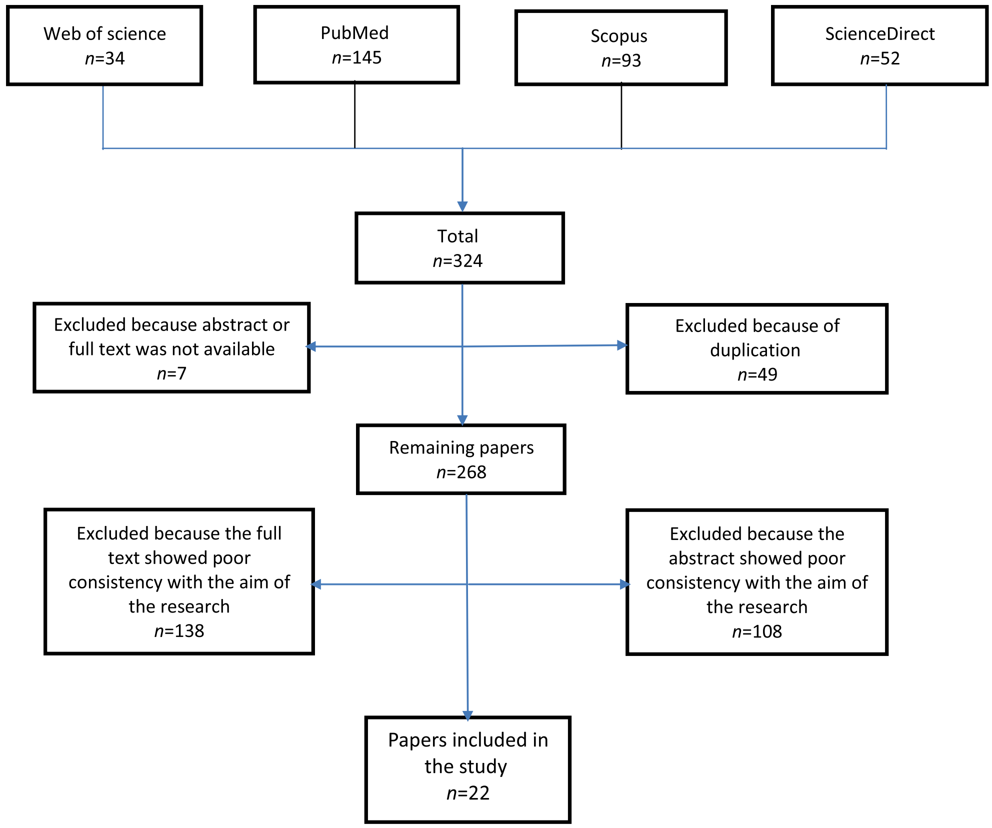

Fig. 1. Process of searching articles.

supplementary data elements consisted of clinical data, severity of injury (mild, moderate and severe) and discharge status.

Mitchell et al.[7] found that the use of understandable MDS and self-defined data elements is essential for exchanging data among different systems. They also emphasized that recording mandatory data, such as injury incidence data, location of injury, activity when the injury occurred, diagnosis and at least one external cause classification and information on injury severity are necessary.

Duan et al.[20] studied the application of an electronic data collection system for integrating injury data sources and promoting data quality. In their study, core data elements were divided into two categories of mandatory and optional data. The mandatory data included national ID number, sex, age and data elements related to the injury. The optional data included race or ethnicity of the injured person, the place of residence of the injured person, education level and occupation.

Epidemiological data

Santijiarakul et al.[13] investigated ISIS and injury data management in 11 countries in Southern Asia and the Mediterranean region. They introduced injury surveillance in the framework of epidemiology which comprised of three parts: (1) surveillance (to know what has happened to whom, where and when), (2) investigation (to confirm the cluster of injury problems, to know or get primary evidence about how and why certain injuries occur in specific risk groups) and (3) epidemiological studies (to gain evidence on the hypotheses derived from surveillance and investigation). This framework depended upon using an MDS along with other supplementary data. The data elements in this study included two domains of general information (name, sex, age, ID number, region, education, occupation) and information about injury (date and time of injury, date and time of visit, mechanism of injury, place of occurrence, activity, nature of injury, severity, injured body part, clinical diagnosis and disposition status).[13]

In another study, Zavala et al.[25] described a pilot project to test the implementation of an epidemiological surveillance system for intentional (violent) and non-intentional injuries at EDs in the selected hospitals of five African countries. In this system, various data elements including type of injury, cause of incidence, time, place and mechanism of injury, injured part of the body and the person's activity during injury were considered. These data were selected based on the guidelines suggested by WHO and the Pan American Health Organization.[25]

Hospital-based data

Motevalian et al.[17] believed that the lack of a unified injury data collection method and the absence of a framework for cooperation among healthcare institutes are the main challenges ahead of effective injury data collection. In their study, data elements such as pre- and post-hospital death, severity and site of injury, monthly follow-up results, way of arrival to the hospital and a link to trauma registry were found to be important for injury surveillance.[17]

In another study, Lakshmi et al.[24] developed a comprehensive hospital-based injury surveillance database. It was developed based on WHO injury surveillance guidelines and had three major sections: patient demographics, details of injury and events after injury. The details of the injury included the intent, mechanism, nature and site of injury, activity that the patient was involved in when the injury occurred, place of injury and alcohol or substance use.

Similarly, Chow et al.[26] developed an electronic ED-based injury surveillance system in Hong Kong. The initial system only collected data on name, sex, age, address, eight general categories of injury types (traffic, domestic, common assault, indecent assault, batter,

Table 1
Data elements and system functions.

No	Author, Year	Data elements	System functions	Results
1	Auer and Anderson[23] (2001)	Personal data: patient demographic data Injury data: intention, date, nature, location, severity, alcohol use, environmental factors, injury outcomes, preventive measures, cause of injury and diagnosis	Basic analyses and report generation at the community level	Strength: promoting disassociation between information and community action. Challenge: obstructing potential linkages between information and action by the external sources of data
2	Sklaver et al.[24] (2008)	Personal data: socio-demographic data Injury data: intention, activity, location, injury mechanism, cause of injury, occupation, severity	Data analysis and dissemination over time, regional data sharing, integrated electronic reporting	Strength: using injury data to structure interventions designed to improve public health outcomes Challenge: collaborating with national and local partners
3	Zavala et al.[25] (2008)	Personal data: socio-economic data Injury data: location, date, nature, activity, alcohol use, drug use	Electronic data collection, data quality control, reporting	Strength: helping researchers to generate evidence-based recommendations by using detailed information Challenge: a sustained commitment of both health care professionals and local health officials
4	Tham et al.[14] (2009)	Personal data: patient demographic data Injury data: activity, diagnosis, cause of injury, nature, intention, time, place, discharge status, jaw & dental injury, sports and traffic incidents, assaults, injury mechanism, protective equipment Financial data	Sending free text data, electronic structured form for collecting orodental injuries, integrating clinical notes into the electronic patient record	Strength: developing an enhanced electronic orodental injury structured history form for collecting key injury surveillance data. Challenge: data quality issues
5	Liu et al.[6] (2009)	Personal data: patient demographic data Injury data: cause of injury, location, intention, severity, clinical procedures, diagnoses and discharge information	Link to the trauma registry, injury reporting, data linkage, data quality control	Strength: making suggestions for developing a national injury surveillance system for China and other low-resource regions Challenge: hiring full-time, professional staff for monitoring injuries in order to provide a better work environment
6	Mitchell et al.[9] (2009)	WHO's core minimum and optimal data sets for injury surveillance	Data linkage, data quality control, security protocols, geocoding, data analysis, data interpretation, routine dissemination of information	Strength: providing a framework tailored to evaluate an injury surveillance system Challenge: using loosely defined characteristics in evaluations
7	Cinnamon and Schuurman[18] (2010)	Personal data: patient demographic data Injury data: causes of injury, type of injury, injury location Spatial data	Link to trauma registry, social web 2.0, geo-web tools for injury surveillance, geocoding, data visualization	Strength: examining the potential for Social Web and GeoWeb technologies to contribute to public health data collection and analysis in low-resource settings Challenge: complying with legal terms and condition as well as paying attention to security breaches
8	Fitzharris et al.[15] (2011)	Personal data: patient demographic data, occupation Injury data: mode of arrival to the hospital, severity, mechanism, location, codes and clinical indicators (e.g., ISS, GCS, RTS, TRISS, AIS), outcomes Financial data	Analyzing data, data quality control	Strength: highlighting the need for the adoption of standardized injury coding indices in the collection and reporting of patient health data Challenge: lack of uniformity in the reporting of patient information and the limited use of standardized severity indices
9	Motevalian et al.[17] (2011)	Personal data: Unique identifier, patient demographic data, region Injury data: date, place, type and outcome mode of arrival to the hospital, situation of the injured patient, alcohol or opioids use, other involved participants in the accident, intention, severity, site of injury, side effects of surgery and medication, one month follow-up results	Integration of injury surveillance system with hospital information system, use of geographical information system (GIS) for data analysis, reporting	Strength: identifying some problems in all components of the current injury surveillance system Challenge: inconsistency in the collected data and underreporting intentional injuries (suicide, interpersonal violence, violence against women or children, domestic violence) in the national injury surveillance system
10	Auer et al.[16] (2011)	Injury surveillance minimum data set	Data collection, analysis, interpretation, dissemination	Strength: offering an ISS evaluation template based on the WHO guidelines Challenge: investigating factors that successfully link the production of injury data with its use and factors that strengthen a system and support sustainability over time
11	Santijiarakul et al.[13] (2012)	Injury surveillance minimum data set	Data entry and transfer, classification and coding, data analysis and reporting	Strength: reviewing the situation of injury surveillance in countries of the Asia-Pacific Region. Challenge: lack of expertise at the country level and paucity of manpower

(*continued on next page*)

Table 1 (*continued*)

No	Author, Year	Data elements	System functions	Results
12	Chow et al.[26] (2012)	Personal data: patient demographic data Injury data: eight general categories of injury types (traffic, domestic, common assault, indecent assault, batter, industrial, self-harm and sports) and disposal from ED Spatial data	Web-based data mining, data quality monitoring, integration of injury surveillance-data with in-patient hospital information, geo-coding and body mapping	Strength: developing an electronic emergency department (ED)-based injury surveillance (IS) system by using data-mining and geo-spatial information technology Challenge: engaging all stakeholders in designing and implementing the system
13	Zhang et al.[27] (2013)	Injury surveillance minimum data set	On-line query systems, data quality control, data linkage	Strength: conducting on-line queries to evaluate system performance Challenge: data quality issues
14	Wainiqolo et al.[3] (2013)	Personal data: patient demographic data Injury data: place, activity, mechanism, intent, nature of injury, use of alcohol, kava and other substances	Data quality control, security protocols	Strength: developing and piloting a population-based trauma registry Challenge: ensuring completeness of data collection
15	Mitchell et al.[7] (2014)	Personal data: unique identifiers, patient demographic data Injury data: place, activity, mechanism, intent, nature of injury, diagnosis, external cause of the injury	Data linkage, web-based data collection, web-based data warehouse	Strength: outlining some of the key issues for injury-related data linkage studies Challenge: Obtaining authorization to link injury data collections and data quality issues
16	Duan et al.[20] (2015)	Personal data: patient demographic data Injury surveillance minimum data set	Data quality control, reporting, link to the hospital information system	Strength: potential to describe injury morbidity and to be utilized to develop national technical and policy document Challenge: data quality issues
17	Calba et al.[28] (2015)	Injury surveillance minimum data set	Graphical representation of the outputs, surveillance network assessment tool, data dissemination, data linkage	Strength: comparing the advantages and limitations of evaluation approaches Challenge: a lack of information regarding the selection of methods and tools to assess the evaluation attributes
18	Lakshmi et al.[29] (2016)	Personal data: socio-demographic data Injury data: intention, mechanism, nature, site of injury, activity, place of injury, alcohol or substance use), and outcomes	Link to trauma registry, generating reliable reports, data quality control	Strength: exploring the feasibility of a secondary level hospital-based surveillance system Challenge: incorporating injury surveillance as a routine feature in the emergency department
19	Lyons et al.[5] (2016)	Emergency department data set Injury data: location, intent, mechanism and activity Joint action on monitoring injuries in Europe minimum data set	Data linkage, data quality control, privacy protocols, web-based injury reporting	Strength: transforming the utility of a traditional single-source surveillance system to a multisource system. Challenge: a lack of data linkage between surveillance systems
20	Martinez et al.[21] (2016)	Personal data: patient demographic data Injury data: intention, mechanism, nature, site of injury, activity, place of injury, alcohol or substance use), and outcomes	Data storage and management, data exploration and visual analytic Data visualization, dashboard, reporting, web-based applications and services for data dissemination, injury tracking	Strength: proposing a visual analytic and visualization platform in public health surveillance for injury prevention and control Challenge: expanding the use of visual analytics and data visualization for injury prevention and control
21	Yeomans et al.[19] (2019)	Personal data: patient demographic data Injury data: nature, site of injury, injury recurrence, treatment/management of injury	Web-based surveillance system, information sharing, injury tracking	Strength: introducing facilitators and barriers to injury surveillance within amateur sport Challenge: poor player adherence and medical staff unavailability
22	Soomro et al.[30] (2019)	Personal data: patient demographic data Injury data: intention, mechanism, nature, site of injury, activity, place of injury, initial treatment, actions taken after the injury, referral	Mobile app, injury reporting, graphical reports, injury tracking, daily fitness tracker, player app, coach app, workload reporting, data analysis	Strength: providing a guide to the architecture and framework for developing an injury surveillance and workload monitoring mobile app Challenge: lack of alerts and reminder alerts

ISS: injury severity score, GCS: Glasgow coma score, RTS: revised trauma score, TRISS: trauma injury severity score, AIS: abbreviated injury score, ED: emergency department.

industrial, self-harm and sports) and disposal from ED. The injury surveillance data were integrated with in-patient hospital information and finally, geo-spatial information and body mapping were added to show the exact place of injury in an electronic map and site of injury on body map.[26]

In a project conducted by Liu et al.[6] in China, injury data were recorded on the injury surveillance forms on a monthly basis and were entered into a database. Then, a trained specialist coded the injuries and their causes. In this project, incomplete data elements were mostly related to the outcomes of injury, diagnoses, and the severity of injury. Name, sex, age, address, date and time of admission, injury cause and location, injury intention, injury severity, procedures, diagnoses and discharge information were among the data elements considered in this study.[6]

In another study, Wainiqolo et al.[3] divided all injury data elements into three sections; namely, demographic data, injury event data, and hospital data. In this study, the minimum data set included demographic data (name, age, gender, ethnicity), details on the injury events (activity, intent, nature and mechanism of injury based on the international classification of diseases, external causes of injury, alcohol abuse, and other substances) and contextual data (date and time of admission and discharge, use of intensive care facilities and outcomes).[3]

Other types of data

In some studies, more specific types of data were suggested to be included in an ISIS. For instance, in a study conducted by Tham et al.[14] the application of ISIS in dental injuries was investigated. In this study, the main data elements included the location of injury, cause of injury, activity at the time of injury, intent and description of injury, discharge/follow-up/referral status. However, diagnostic data were related to oral and dentistry injuries, such as concussion, subluxation, intrusive luxation, extrusive luxation, lateral luxation, and avulsion.[14]

The use of classification systems and determining the severity score of injury are important in an ISIS.[3] The findings of the study conducted by Fitzharris et al.[15] showed that international classifications such as ICD-10, injury severity score, Glasgow coma score, revised trauma score, and abbreviated injury scale could be used in ISISs. In this study, the authors emphasized the use of MDS as a tool for improving the quality of injury documentation and evidence-based policy-making. They also stated that no job-related information is available in most cases of injury, and there is only a limited document available about pre-hospital health care and finances.[15]

Zhang et al.[27] compared online queries of job-related injuries by using three ISISs. The ISIS in the US could search eight data elements (treatment dates, product codes, sex, age, body part, diagnosis, location and disposition), the ISIS of the European Union could search 13 data elements, and Japan's injury information data bank could search nine data elements including date of accident, product name, manufacturer/importer, type of injury, details of accident, usage period of the product, cause of accident, and measures for recurrence prevention of accident). The results of this study showed that the system in the US had a better performance.[27]

In another study, Auer and Anderson[23] stated that in addition to the minimum data set, injury due to environmental causes (e.g. road condition), treatment outcomes, preventive measures (such as fastening the seatbelt), brief description of the event, diagnosis of injury based on the international classification of diseases, external causes of injury, and the severity of injury should be considered for injury surveillance systems.

ISIS functions

The results showed that few studies discussed the functions of ISIS. Some of these functions are injury tracking, data monitoring, data linkage, using geographic information system (GIS)/Geoweb, reporting, analyzing and disseminating data as well as using security standards which are presented in the following sections.

Injury tracking

Sklaver et al.[24] believed that ISIS is vital for outcome evaluation, and defined an electronic structure for it which could collect, track, and share injury data as well as generate reports for different levels of the healthcare system. Duan et al.[20] recommended the use of electronic reporting and found these reports useful for injury tracking. In another study, Yeomans et al.[19] introduced injury tracking as a system function which is necessary for accessing injury data. The researchers noted that before creating a system, injury data flow should be investigated in detail to be able to track injuries.[19]

Data monitoring

Injury data must be continuously monitored to ensure that data quality is extremely high. Therefore, it is essential to design an appropriate database. Accordingly, Cinnamon et al.[18] indicated that ISIS provides an opportunity to exchange data electronically and reduce data quality challenges. Similarly, the results of the study conducted by Lakshmi et al.[29] showed that a large electronic database can support injury surveillance processes and overcome data quality issues. Similarly, Motevalian et al.[17] explained that an appropriate database for an ISIS should be able to monitor data quality continuously.

Data linkage

Data linkage is among the most important functions of an ISIS and generally, it is expected that different types of injury data are collected and transferred from multiple sources and different organizations into the ISIS.[21] Lyons et al.[5] considered data linkage as an essential component for monitoring and promoting data quality. Mitchell et al.[7] found it as a key function for the system and believed that the process of linking data can be more effective by using a web-based data warehouse. Similarly, Motevalian et al.[17] argued that single-source systems often failed to record all injury data or they only recorded part of the necessary data, which did not have much value for injury surveillance. In this case, loss of important data posed a challenge to injury prevention and control.

GIS/Geoweb

According to the findings, GIS helps to identify the location of injury and at-risk populations. Chow et al.[26] found that geo-spatial surveillance system collected valuable information for safety promotion and injury prevention. In their study, the use of geo-codes showed the exact place of injury in an electronic map and facilitated injury management processes. In another study, Martinez et al.[21] indicated that in addition to the data elements suggested by WHO, GIS should be used to speed up injury management processes and identify at-risk regions and populations. Similarly, the use of Geocode and Geoweb tools provides an opportunity for getting an easier access to data related to the location of injury.[18]

Reporting

According to Chow et al.,[26] multi-level reporting for injury was a key function of the ISIS. The findings of their study revealed that care for injured persons could be enhanced via electronic and visual reporting of injury events.[26] In another study, Auer et al.[16] discussed different types of web-based reporting tools which can assist managers and policy-makers to generate the reports that they needed.

Analytics tools

Data discovery and generating reports can help to increase the chance of using the data by policy-makers and injury surveillance managers. Martinez et al.[21] highlighted the importance of using data visualization platforms in ISIS to generate various types of graphs and diagrams. Similarly, Calba et al.[28] discussed the application of a system which could produce visual outputs.

Data dissemination

The possibility of distributing injury data is another important function of an ISIS which is performed based on data sources and access levels to injury data.[1,13] Before data dissemination, injury data need to be filtered and summarized according to the confidentiality policies and users' requirements. This approach can maintain the privacy of data while reducing costs and time.[21] Dashboards are useful tools for data distribution. They considerably reduce costs, prevent loss of data, and offer timely and understandable reports.[12]

Security standards

The appropriate use of security standards is a key factor affecting data linkage and data exchange among healthcare organizations or other institutions involved in injury surveillance.[19,26] Aure et al.[16] highlighted security and confidentiality as the attributes of a good injury surveillance system. In fact, a lack of a secure context for data exchange can lead to inefficiency and disruption in other system functions.[7,21]

According to Lyons et al.,[5] applying security standards is necessary for an ISIS. In this case, the injury data can be protected and collected continuously from all regions and the process of injury surveillance can be improved. It is also argued that the use of web-based security protocols can help to promote security and privacy of data.[19] In another study, Santijiarakul et al.[13] believed that ISIS must be able to link data sources in a secure and private environment in order to improve the integrity and confidentiality of injury data.

Discussion

The ISIS provides useful information for developing strategies, planning, implementing interventions and allocating resources in injury prevention. This system helps to improve the accessibility of information at any time and any place and facilitates predicting injuries as well as linking data from various sources and regions.[7,24,31]

The results of the present study revealed that the data elements required for the ISIS are diverse. While the majority of studies used the minimum data set suggested by WHO, in some studies, more supplementary data elements were proposed to cover different aspects of injury.[21,23,26] For example, some researchers suggested adding ICD-10 codes to complement data elements.[3,5,7,9,13,15,23]

The use of several data elements helps to gain a better understanding of the injury concept and facilitates the process of injury monitoring and surveillance. Moreover, these data can be used for different levels of injury prevention which include primary prevention (to prevent injury events), secondary prevention (to mitigate the nature and severity of injury), and tertiary prevention (to offer timely and appropriate medical care and rehabilitation).[30]

It is noteworthy that with respect to the large volume of injury data, applying an electronic system seems to be inevitable to simplify the process of data collection.[8,26] Since the majority of healthcare centers possess scattered data on injury, it is essential to pay more attention to the data standardization and quality in the ISIS. To achieve this, data collection processes should be defined and online tools need to be developed.[24] The results of the present study suggested that the ISIS should act like a quality control tool to check the quality of the data, because in the future the valid decision will depend on the current data quality.[3–5,9,11,13–17,27]

According to the results, the functions of the ISIS must be in line with the requirements of those who use the data. In fact, improving system functions and resolving challenges can help to improve the acceptance level of the system, leading to a better use of the system.[11,16] For instance, the results of the study conducted by Watson et al.[32] showed that data linkage can prevent data loss, enhance the quality of data analysis and interpretation and clearly demonstrate feedback at all levels. In another study, Bunn et al.[33] discussed the cost-effectiveness of data linkage and suggested to use ED data for injury surveillance to save time, resources and costs. They believed that this approach increased the precision of decision-making processes and promoted the quality of care.[33]

In terms of injury data analysis and distribution, some researchers noted that the system must reduce the complexity in the data and be used for data discovery, data sharing and injury monitoring and tracking by using visual reports, such as graphs, figures, maps, Geoweb tools and GIS.[9,15,26] Therefore, it seems that useful system functions can considerably decrease the costs, prevent data repetition and loss of data, and offer timely and understandable reports as well as effective feedback.[21] Finally, it must be declared that the opinions of clinical staff and injury surveillance experts should be carefully considered before designing ISIS because they are the main users of the system. This approach can ensure successful system implementation in the future.

In the current study, data elements and functions required for an ISIS were reviewed to gain a better understanding of the system for future development. However, this study had some limitations. First of all, the number of databases was limited. Although only four databases were searched due to the time and resource restrictions, they were the most relevant databases and the researchers believed that they could obtain relevant papers for the study. The second limitation was related to the number of the selected papers for the study. In fact, the number of studies with adequate details about the data elements and the function of an ISIS were very limited and the researchers had to select the most relevant studies to the topic of research. Moreover, the search was limited to the full text published papers in English between 2000 and 2019. Therefore, there might be papers and documents which have been discarded from the study due to not meeting the inclusion criteria. As a result, conducting a more rigorous systematic review is proposed for the future.

The accuracy, precision and completeness of injury data documentation and management can be promoted by using standard data elements, controlling data quality, linking data sources, and utilizing security and privacy protocols. Therefore, an integrated information system is necessary to collect accurate and timely data about the injury for future decision making and public health interventions. These features can be considered in an ISIS. This system includes a minimum data set (e.g. demographic information and injury data, such as the type, nature, and mechanism of injury) as well as the supplementary data describing the injury event, such as the environmental condition. Along with the data elements, system functions, such as data linkage, data monitoring, reporting, data analysis and distribution should be considered.

Since different countries have various technical and organizational infrastructures, it is essential to identify system requirements and injury data flow in different settings. Moreover, it is necessary to conduct a feasibility study to examine the opportunities and challenges ahead of system design and implementation. Future studies should also consider the influence of new technology and social media on collecting injury data.

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Ethical Statement

Ethical clearance was obtained from the institutional ethics committee of the hospital before the start of the study. Written informed consent was obtained from each patient before the conduct of the study.

Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

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